IN THE MATTER OF

U.S. Patent Application No. 09/609,822

By Samsung Electronics Co., Ltd.

I, Soon-hee Lee, an employee of Y.P.LEE,MOCK & PARTNERS of The Cheonghwa Bldg., 1571-18 Seocho-dong, Seocho-gu, Seoul, Republic of Korea, hereby declare that I am familiar with the Korean and English languages and that I am the translator of the priority document (Korean Patent Application No. 1998-4071) and certify that the following is to the best of my knowledge and belief a true and correct translation.

Signed this 14th day of September 2004.

Soon hee Lee

ABSTRACT

[Abstract of the Disclosure]

An adaptive writing method for a high-density optical recording apparatus and an device thereof are provided. The device includes a discriminator for discriminating the magnitude of the present mark of the input data and the magnitudes of the leading and/or trailing spaces, a generator for controlling the waveform of the write pulse in accordance with the magnitude of the present mark of the input data and the magnitudes of the leading and/or trailing spaces to generate an adaptive write pulse, and a driver for driving the light source by converting the adaptive write pulse into a current signal in accordance with driving power levels for the respective channels. The widths of the first and/or last pulses of a write pulse waveform are varied in accordance with the magnitude of the present mark of input NRZI data and the magnitude of the leading and/or trailing spaces, thereby minimizing jitter to.enhance system reliability and performance.

[Representative Drawing]

FIG. 2

SPECIFICATION

[Title of the Invention]

Adaptive Writing Method for High-Density Optical Recording Apparatus and Device Thereof

[Brief Description of the Drawings]

FIGS. 1A through 1E are waveform diagrams of conventional write pulses;

FIG. 2 is a block diagram of an adaptive writing device for a high-density optical recording apparatus according to an embodiment of the present invention; and

FIGS. 3A through 3C are waveform diagrams of an adaptive write pulse recorded by the adaptive writing device shown in FIG. 2.

[Detailed Description of the Invention]

[Object of the Invention]

[Technical Field of the Invention and Related Art prior to the Invention]

The present invention relates to an adaptive writing method for a high-density optical recording apparatus and a device thereof, and more particularly, to an adaptive writing method for optimizing light power of a laser diode and a circuit thereof.

With the multi-media era requiring high-capacity recording media, optical recording systems employing high-capacity recording media, such as a magnetic optical disc drive (MODD) or a digital versatile disc random access memory (DVD-RAM) drive, have been widely used.

As the recoding density increases, such optical recording systems require optimal and high-precision states. In general, with an increase in recording density, temporal fluctuation (to be referred to as jitter, hereinafter) in a data domain increases. Thus, in order to attain high-density recording, it is very important to minimize the jitter.

Conventionally, a write pulse is formed as specified in the DVD-RAM format book shown in FIG. 1B, with respect to input NRZI (Non-Return to Zero Inversion) data having marks of 3T, 5T and 11T (T being the channel clock duration), as shown in FIG.

1A. Here, the NRZI data is divided into mark and space. The spaces are in an erase power level for overwriting. The waveform of a write pulse for marks equal to or longer than 3T mark, that is, 3T, 4T,...11T and 14T is comprised of a first pulse, a last pulse and a cooling pulse. Here, only the number of pulses in the multi-pulse train is varied.

In other words, the waveform of the write pulse is comprised of a combination of read power (FIG. 1B), peak power or write power (FIG. 1C) and bias power or erase power (FIG. 1D).

The waveform of the write pulse is the same as that in accordance with the first generation 2.6 GB DVD-RAM standard. In other words, in accordance with the 2 GB DVD-RAM standard, the waveform of the write pulse is comprised of a first pulse, a multi-pulse train and a last pulse. The rising edge of the first pulse of a fundamental write pulse is present in the point T/2 later than the rising edge of the write mark and shifts back and forth in a 1ns (nono second) unit. The last pulse can also shift in a 1 ns unit. The multi-pulse train prevents the deformation of the write marks by reducing accumulation of heat in the back ends of the write marks due to division into several short pulses.

In such a write pulse structure, a write pulse waveform is used irrespective of a leading space and a trailing space.

Therefore, when a write operation is performed by forming such a write pulse as shown in FIG. 1E, severe thermal interference may occur back and forth with respect to a mark in accordance with input NRZI data. In other words, when a mark is long and a space is short or vice versa, jitter is most severe. This is a major cause of lowered system performance. Also, this does not make it possible for the system to be applied to high-density DVD-RAMs, e.g., second generation 4.7 GB DVD-RAMs.

[Technical Goal of the Invention]

To solve the above problems, it is an objective of the present invention to provide an adaptive writing method of a write pulse generated in accordance with the magnitude of the present mark of input NRZI data and the magnitudes of the leading space thereof.

It is another objective of the present invention to provide an adaptive writing device for a high-density optical recording apparatus for writing an adaptive write pulse generated in accordance with the magnitude of the present mark of input NRZI data and the magnitudes of the leading space thereof.

Accordingly, to achieve the first objective, there is provided a method for controlling an optical power of a laser diode, the adaptive writing method including the steps of controlling the waveform of the write pulse in accordance with the magnitude of the present mark of the input data and the magnitudes of the leading space to generate an adaptive write pulse, and driving the laser diode by converting the adaptive write pulse into a current signal in accordance with driving power levels for the respective channels.

To achieve the second objective, there is provided an apparatus for controlling an optical power of a laser diode, the adaptive writing device including a discriminator for discriminating the magnitude of the present mark of the input data and the magnitudes of the leading space, a generator for controlling the waveform of the write pulse in accordance with the magnitude of the present mark of the input data and the magnitudes of the leading space to generate an adaptive write pulse, and a driver for driving the laser diode by converting the adaptive write pulse into a current signal in accordance with driving power levels for the respective channels.

[Structure and Operation of the Invention]

Hereinafter, a preferred embodiment of an adaptive writing method for a high-density optical recording apparatus and a device thereof will be described with reference to the accompanying drawings.

For the waveform of the write pulse for the second generation, i.e., 4.7 GB DVD-RAM, an adaptive write pulse considering the leading space and/or the trailing space of the write mark will be used.

In detail, an adaptive writing device according to the present invention, as shown in FIG. 2, includes a data discriminator 102, a write waveform controller 104, a microcomputer 106, a write pulse generator 108, and a current driver 110.

In other words, the data discriminator 102 discriminates input NRZI data. The write waveform controller 104 corrects the waveform of a write pulse in accordance with the discrimination result of the data discriminator 102 and land/groove signal. The microcomputer 106 initializes the write waveform controller 104 or controls the data stored in the write waveform controller 104 to be updated in accordance with write conditions. The write pulse generator 108 generates an adaptive write pulse in accordance with the output of the write waveform controller 104. The current driver 110 converts the adaptive write pulse generated from the write pulse generator 108 into a current signal in accordance with the light power levels of the respective channels to drive a light source.

Next, the operation of the device shown in FIG. 2 will be described.

In FIG. 2, the data discriminator 102 discriminates the magnitude of the front-part space corresponding to the first pulse of the present mark (to be referred to as a leading space, hereinafter) and the magnitude of a mark corresponding to the present write pulse (to be referred to as a present mark) from input NRZI data, and applies the magnitude of the leading space and the magnitude of the present mark to the write waveform controller 104.

The write waveform controller 104 shifts the rising edge of the first pulse back and forth in accordance with the magnitudes of the leading space and the present mark, supplied from the data discriminator 102, or shifts the falling edge of the last pulse back and forth in accordance with the magnitude of the present mark, to thus find a write waveform having an optimal light power and generate data corresponding to the width of the first pulse of the present mark and data corresponding to the width of the last pulse. In this case, the rising edge of the first pulse of the write pulse synchronizes with the rising edge of the present mark. For an optimal light power of a laser diode, the read light power for a predetermined channel is applied during the period

corresponding to the shift of the rising edge of the first pulse and during the period corresponding to the shift of the falling edge of the last pulse.

Also, the write waveform controller 104 can correct the rising edge of the first pulse of the present mark and the falling edge of the last pulse of the present mark into different values in accordance with externally applied land/groove signals (LAND/GROOVE) indicating whether the input NRZI data is in a land track or a groove track. This is for forming a write waveform in consideration of different optimal light powers depending on the land and groove.

Therefore, the write waveform controller 104 may be constituted by a memory in which data corresponding to the width of the first pulse and the width of the last pulse in accordance with the magnitude of the present mark of input NRZI data and the magnitude of the leading space thereof, is stored, or a logic circuit. Also, in this memory, the widths of the first and last pulses of the mark for each of a land and a groove may be stored. A microcomputer 106 initializes the write waveform controller 104 or controls the width data of the first and/or last pulse(s) to be updated in accordance with recording conditions.

The pulse width data for controlling the waveform of the write pulse is provided to the write pulse generator 108. The write pulse generator 108 generates an adaptive write pulse in accordance with the pulse width data for controlling the waveform of the write pulse supplied from the write waveform controller 104 and supplies control signals for controlling the current flow for the respective channels (i.e., read, peak and bias channels) for the adaptive write pulse, to the current driver 110.

The current driver 110 converts the driving level of the light power of the respective channels (i.e., read, peak and bias channels) into current for a control time corresponding to the control signal for controlling the current flow of the respective channels to allow the current to flow through the laser diode so that an appropriate amount of heat is applied to the recording medium by continuous ON-OFF operations of the laser diode or a change in the amounts of light.

FIG. 3A shows input NRZI data, which is divided into mark and space. FIG. 3B shows a basic write waveform, in which the rising edge of the present mark synchronizes with the rising edge of the first pulse of the write pulse.

FIG. 3C shows the waveform of the adaptive write pulse proposed in the present invention. The first pulse of the write waveform of the adaptive write pulse may be shifted back and forth in accordance with a combination of the magnitude (T_1) of the leading space and the magnitude (T_2) of the present mark. The last pulse of the adaptive write pulse may be shifted back and forth in accordance with the magnitude (T_2) of the present mark. Because the present invention does not consider the magnitude (T_3) of the trailing space of the preset mark, time can be shortened.

A new adaptive writing method according to the present invention can be adopted to most high-density optical recording apparatuses using an adaptive writing pulse.

[Effect of the Invention]

As described above, the widths of the first and/or last pulses of a write pulse waveform are varied in accordance with the magnitude of the present mark of input NRZI data and the magnitude of the leading space, thereby minimizing jitter to enhance system reliability and performance.

What is claimed is:

1. In a method for controlling an optical power of a laser diode, an adaptive writing method comprising the steps of:

(a) controlling the waveform of the write pulse in accordance with the magnitude of the present mark of the input data and the magnitudes of the leading space to generate an adaptive write pulse, and

(b) driving the laser diode by converting the adaptive write pulse into a current signal in accordance with driving power levels for the respective channels.

2. The adaptive writing method according to claim 1, wherein in step (a), the rising edge of the first pulse of the write pulse synchronizes with the rising edge of the present mark, the first pulse shifts back and forth in accordance with the magnitudes of the leading space and the preset mark, and the last pulse of the write pulse shifts back and forth in accordance with the magnitude of the present mark.

3. The adaptive writing method according to claim 2, wherein the read light power for a predetermined channel is applied during the period corresponding to the shift of the rising edge of the first pulse and during the period corresponding to the shift of the falling edge of the last pulse.

4. The adaptive writing method according to claim 1, further comprising the step of:

(c) correcting the waveform of the adaptive write pulse in accordance with a land/groove signal indicating whether the input NRZI data is data of a land track or data of a groove track.

5. The adaptive writing method according to claim 1, wherein the controlled write pulse excludes the consideration of the trailing space of the present mark to shorten the time retardation.

6. In a method for writing input data on an optical recording medium by a write pulse whose waveform is comprised of a first pulse, a multi-pulse train, and a last pulse, for optimizing the read, peak, and bias light power of a laser diode, an adaptive writing method comprising the steps of:

(a) discriminating between the magnitudes of a leading space of input NRZI data and a present mark thereof;

(b) generating pulse width data for varying the widths of first and/or last pulses of the write pulse waveform in accordance with the magnitude of the leading space and the magnitude of the present mark; and

(c) generating an adaptive write pulse in accordance with the pulse width data, converting the adaptive write pulse into a current signal in accordance with the driving power levels for the respective channels for the adaptive write pulse to drive the laser diode.

7. The adaptive writing method according to claim 6, wherein the step (b) comprises the sub-steps of:

(b1) generating first pulse width data for shifting the rising edge of the first pulse of the write pulse synchronized with the rising edge of the mark backward in accordance with the magnitude of the leading space and the magnitude of the present mark; and

(b2) generating first pulse width data for shifting the falling edge of the last pulse of the write pulse back and forth in accordance with the magnitude of the present mark.

8. The adaptive writing method according to claim 7, wherein the read light power for a predetermined channel is applied during the period corresponding to the shift of the rising edge of the first pulse and during the period corresponding to the shift of the falling edge of the last pulse.

9. The adaptive writing method according to claim 6, further comprising the step of:

(d) correcting the widths of the first pulse and the last pulse of the adaptive write pulse in accordance with a land/groove signal indicating whether the input NRZI data is data of a land track or.data of a groove track.

10. The adaptive writing method according to claim 6, wherein the adaptive write pulse excludes the consideration of the trailing space of the present mark to shorten the time retardation.

11. In an apparatus for controlling an optical power of a laser diode, an adaptive writing device comprising:

a discriminator for discriminating the magnitude of the present mark of the input data and the magnitudes of the leading space,

a generator for controlling the waveform of the write pulse in accordance with the magnitude of the present mark of the input data and the magnitudes of the leading space to generate an adaptive write pulse, and

a driver for driving the laser diode by converting the adaptive write pulse into a current signal in accordance with driving power levels for the respective channels.

12. The adaptive writing device according to claim 11, wherein the generator includes a write waveform controller for generating pulse width data for varying the width of the first pulse in accordance with the magnitude of the leading space and the magnitude of the present mark and varying the width of the last pulse in accordance with the magnitude of the present mark, and a write pulse generator for generating an adaptive write pulse in accordance with the pulse width data.

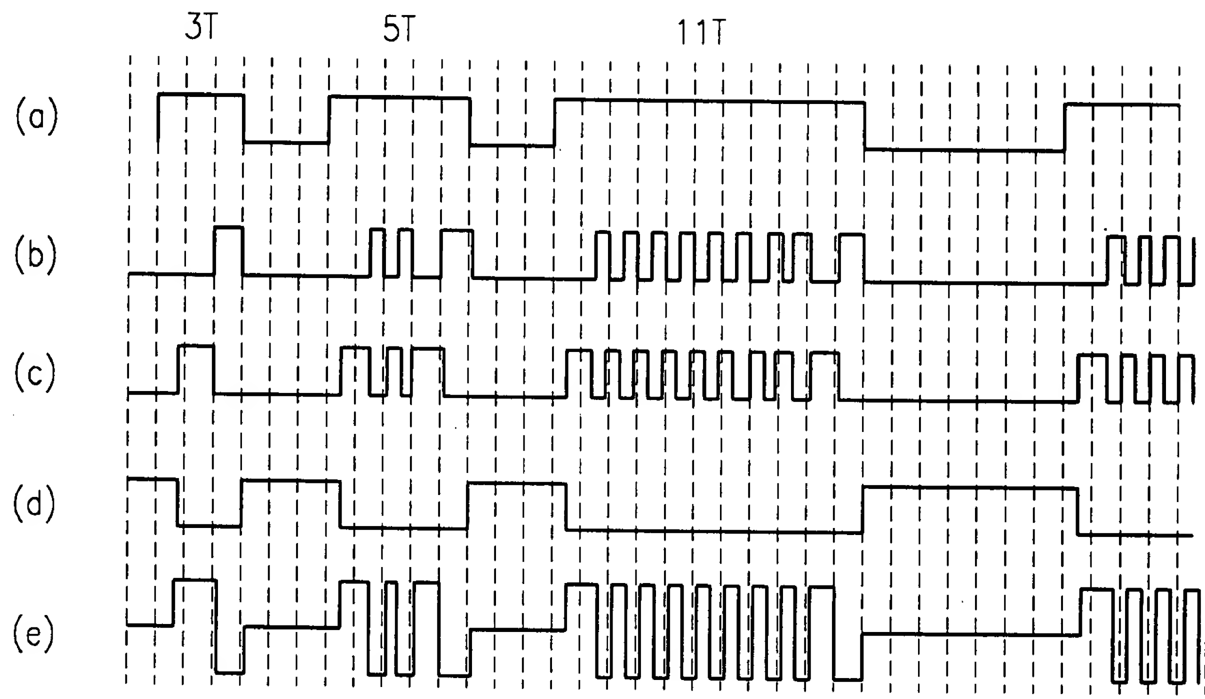
13. The adaptive writing device according to claim 12, further comprising a microcomputer for initializing the write waveform controller and controlling the pulse width data stored in the memory to be updated in accordance with write conditions.

14. The adaptive writing device according to claim 12, wherein the memory stores width data of the first and/or last pulses of a write pulse waveform depending on whether the input data is in a land track or a groove track.

15. The adaptive writing device according to claim 12, wherein the read light power for a predetermined channel is applied during the period corresponding to the shift of the rising edge of the first pulse and during the period corresponding to the shift of the falling edge of the last pulse.

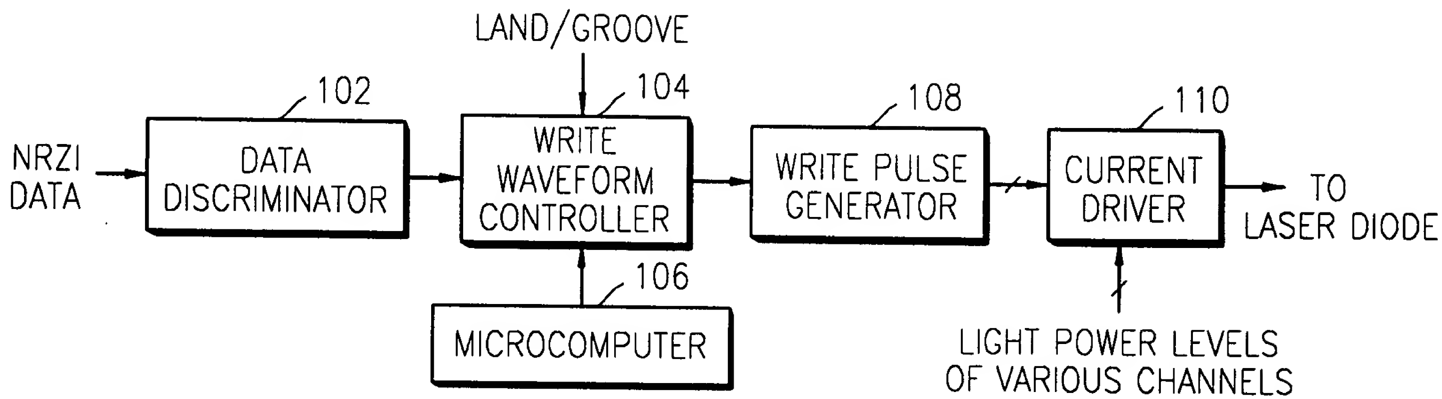
16. The adaptive writing device according to claim 11, wherein the adaptive write pulse excludes the consideration of the trailing space of the present mark to shorten the time retardation.

FIG. 1



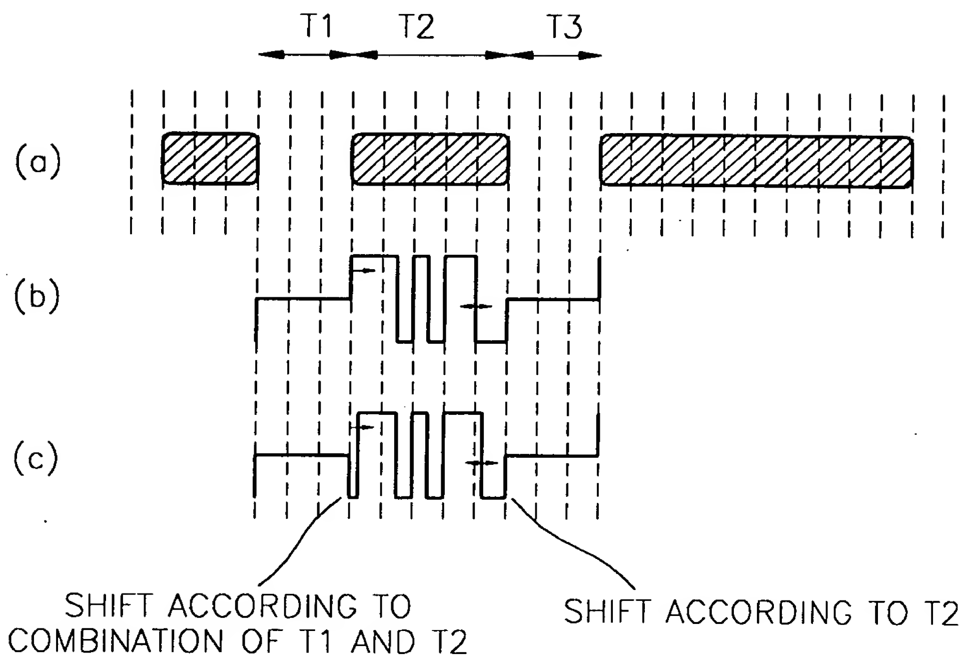
3T
5T
11T
(a)
(b)
(c)
(d)
(e)

FIG. 2



LAND/GROOVE
NRZI DATA
102
DATA DISCRIMINATOR
104
WRITE WAVEFORM CONTROLLER
106
MICROCOMPUTER
108
WRITE PULSE GENERATOR
110
CURRENT DRIVER
TO LASER DIODE
LIGHT POWER LEVELS OF VARIOUS CHANNELS

FIG. 3


T1
T2
T3
(a)
(b)
(c)
SHIFT ACCORDING TO
COMBINATION OF T1 AND T2
SHIFT ACCORDING TO T2